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IS 8161-3-2 (1986): Guide for Equipment Reliability Testing, Part 3: Preferred Test Conditions for Equipment Reliability Testing, Section 2: Equipment for Stationery Use in Weather Protected Locations (High Degree of Simulation) [LITD 2: Reliability of Electronic and Electrical Components and Equipment]



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“Knowledge is such a treasure which cannot be stolen”

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IS : 8161 (Part 3/Sec 2) - 1986

(Reaffirmed 2001)

Indian Standard

GUIDE FOR EQUIPMENT RELIABILITY TESTING

PART 3 PREFERRED TEST CONDITIONS FOR EQUIPMENT RELIABILITY TESTING

Section 2 Equipment for Stationary Use in Weather Protected Locations (High Degree of Simulation)

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Indian Standard

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PART 3 PREFERRED TEST CONDITIONS FOR EQUIPMENT RELIABILITY TESTING

Section 2 Equipment for Stationary Use in Weather Protected Locations (High Degree of Simulation)

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Indian Standard

GUIDE FOR EQUIPMENT RELIABILITY TESTING

PART 3 PREFERRED TEST CONDITIONS FOR EQUIPMENT RELIABILITY TESTING

Section 2 Equipment for Stationary Use in Weather Protected Locations (High Degree of Simulation)

0. FOREWORD

0.1 This Indian Standard (Part 3/Sec 2) was adopted by the Indian Standards Institution on 6 November 1986, after the draft finalized by the Reliability of Electronics and Electrical Components and Equipment Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 This standard which deals with the reliability requirements when these are expressed as a success ratio is the third in the series of Indian Standards for equipment reliability testing. To be able to write a detailed reliability test specification and perform a reliability test, the test engineer will need additional information which are dealt within detail in other standards in this series. A list of standards envisaged in this series so far, is given on page 13.

0.3 This standard is largely based on IEC Document 56 (C.O.) 100 Draft-IEC Publication 605-3 Preferred test conditions for equipment reliability testing, Test Cycle 2 : Equipment for stationary use in weather protection locations, Case 2 : High degree of simulation, issued by the International Electrotechnical Commission.

1. SCOPE

1.1 This standard (Part 3/Sec 2) recommends preferred test conditions for equipment for stationary use in weather protected locations with high degree of simulation.

2. INTRODUCTION

2.1 This standard contains preferred test conditions as referred to in IS : 8161 (Part 1)-1976*. Whenever possible, test cycles should be chosen from among those given in this or other Sections of this standard. For applications not covered by this standard, appropriate test cycles should be designed using IS : 8161 (Part 2)-1986*.

2.2 These test cycles are sequences of different operating and environmental conditions which are based upon actual use conditions, as defined, for example, by the relevant product specification.

2.3 The main object of presenting preferred test conditions is to ensure that equipments with similar applications, albeit different in form, fit and function are subjected to the same test conditions. This also facilitates comparisons.

2.4 Test cycles are presented with different degrees of simulation of use conditions. A cycle with a low degree of simulation is simplified with respect to one or more of the following aspects:

- number of environmental parameters,
- number of stress levels for the environmental parameters involved,
- number of possible modes of equipment operation, and
- sequence and combination of these parameters.

2.5 A cycle with a high degree of simulation is more complex and is closer to the actual use conditions, but also more costly to realise and to perform by practical testing. A high degree of simulation is recommended when the outcome of the test is crucial, for example, when failure consequences are critical in terms of safety and economic loss, or in conflict with regulations, as with environmental pollution. Where failure consequences are less important, for example, TV and radio for entertainment, a low degree of simulation of use conditions may be used.

2.6 It shall also be realized that the same type of equipment may be used in different applications, requiring testing to different test cycles/sections of this standard. Furthermore, it is possible that, if failure consequences dictate, the same type of equipment may also be tested to different degree of simulation.

2.7 In the case of a low degree of simulation, the test cycles have been simplified. However, the reproducibility and the repeatability of the tests are maintained with respect to the failure modes and the value of

*Guide for equipment reliability testing:

Part 1 Principles and procedures.

Part 2 Design of test cycles.

the reliability characteristic. It is expected that these are consistent on different occasions and in different laboratories when testing the same equipment.

2.8 Reproducibility is also expected to be maintained between tests with different degrees of simulation, but the tests with a high degree of simulation will give results closer to the field reliability.

3. APPLICABILITY

3.1 The test conditions specified in this standard are applicable to equipment for stationary use in weather protected locations satisfying following:

- | | | |
|------------------------------------|--|--------------------------|
| a) <i>Type of Equipment</i> | Equipment or functional units for stationary use. | |
| b) <i>Operating Conditions</i> | i) Operating while in stationary position only.
ii) The equipment is either switched off once a day or is continuously powered.
iii) Operation and maintenance according to equipment specification.
iv) Power supply from battery or mains. | |
| c) <i>Environmental Conditions</i> | i) Weather protected locations.
ii) Ambient temperature is normally between 16°C and 33°C with extreme values of 5°C and 40°C.
iii) Relative humidity normally between 19 percent and 70 percent with extreme values of 5 percent and 85 percent.
iv) Equipment subjected to occasional vibration, but not to significant shocks. | |
| d) <i>Degree of Simulation</i> | High | |
| e) <i>Examples</i> | <i>Equipment</i> | <i>Conditions</i> |
| | Telecommunication equipment, teletypewriter | Office |
| | Mini and micro-computers with peripherals | Office or home |
| | Process and machine control equipment | Workshop or control room |

4. RELEVANT PERIOD OF EQUIPMENT LIFE COVERED BY THE TEST CYCLE

4.1 The test cycle covers the activities of the tested equipment which occur during its normal use. During operation the equipment is deemed to be stationary and to be maintained by trained personnel according to specified maintenance requirements.

4.2 Transportation from the factory to the site or use and long periods of storage are not taken into account in the test cycle. However, it is possible that the long term reliability is sensitive to storage and transportation influences. If so, it is recommended that preparatory tests be performed (packaged where appropriate) on the same test items to simulate the effects of these phases of life on the equipment reliability. These preparatory tests cannot replace appropriate qualification tests of the packaging.

5. BASIC ASSUMPTIONS UNDERLYING THE SEVERITIES

5.1 Operating Conditions

5.1.1 Supply Voltage — The value of the mains supply voltage may vary by ± 10 percent of the nominal. If the equipment manufacturer specifies closer tolerances, these shall have to be applied.

5.1.2 Interference by Transient Voltages — Transients on the supply voltage which are always applicable, are taken into consideration in the design of the test cycle. They can be frequent (about 1 surge in 10 h) and high (from 400 V to 2 000 V). However, surges exceeding peak values ten times the nominal voltage are rare. The transients of short duration (typically 1 ms) are most frequent and are, therefore, included in the test cycle.

5.1.2.1 Other transients and other sources of interference may affect equipment reliability but are not explicitly considered, being too specific to individual applications or equipment. For example, in equipment connected to long signal input lines transients up to:

- 450 V rms, at power line frequency, 0.2 s (power line interference),
- 1.5 kV, 10/700 (microseconds) (lightning interference, pulse definition),

can exist on these lines. These other transients should be described in the relevant equipment reliability test specification.

5.1.3 Equipment Functional Modes — The equipment to be tested is assumed to be switched on and off at least once a day, with power applied for at least 20 percent of total time. This will not apply, however, to equipment which is continuously in operation in normal use.

5.2 Climatic Conditions

5.2.1 The equipment is deemed to operate in a weather protected location, as described below:

- temperature controlled location,
- heating or cooling may be switched off for periods, but occurrence of extremely low temperatures is prevented,
- additional humidification may be used where necessary, to avoid extremely dry conditions,
- the building construction provides protection from daily variations in the outside climate,
- power dissipation of the equipment in the location (room) should not cause the ambient temperature to exceed the limits in **3.1**. Otherwise, additional cooling is needed.

With the provision of the above-described location, it may be assumed that the extreme conditions as encompassed by the climatogram shown in Fig. 1 will not be exceeded.

5.2.2 Further indications on the statistical distribution inside the climatogram shown cannot be given generally. They depend on the diurnal and seasonal variations of the outdoor climate.

5.3 Mechanical Conditions

5.3.1 *Vibration* — The equipment is deemed to operate in locations either without significant vibrations, or with only low level vibrations from ground vehicles transmitted to the mounting structure, or from machines in the vicinity.

5.3.1.1 For equipment directly mounted on the following severities are assumed:

- a) It is expected that the following **EXTREME** values of sinusoidal vibration amplitudes with frequencies f of up to 150 Hz are not exceeded:
 - $f < 10$ Hz : constant displacement = 0.125 mm
 - $10 < f < 50$ Hz : constant velocity = 7.8 mm/s
 - $50 < f < 150$ Hz : constant acceleration = 2.5 m/s²
- b) It is further expected that the following **NORMAL** values of sinusoidal vibration amplitudes with frequencies of up to 55 Hz are not exceeded:
 - $f < 5$ Hz : constant displacement = 0.04 mm
 - $5 < f < 40$ Hz : constant velocity = 1.25 mm/s
 - $40 < f < 55$ Hz : constant acceleration = 0.3 m/s²

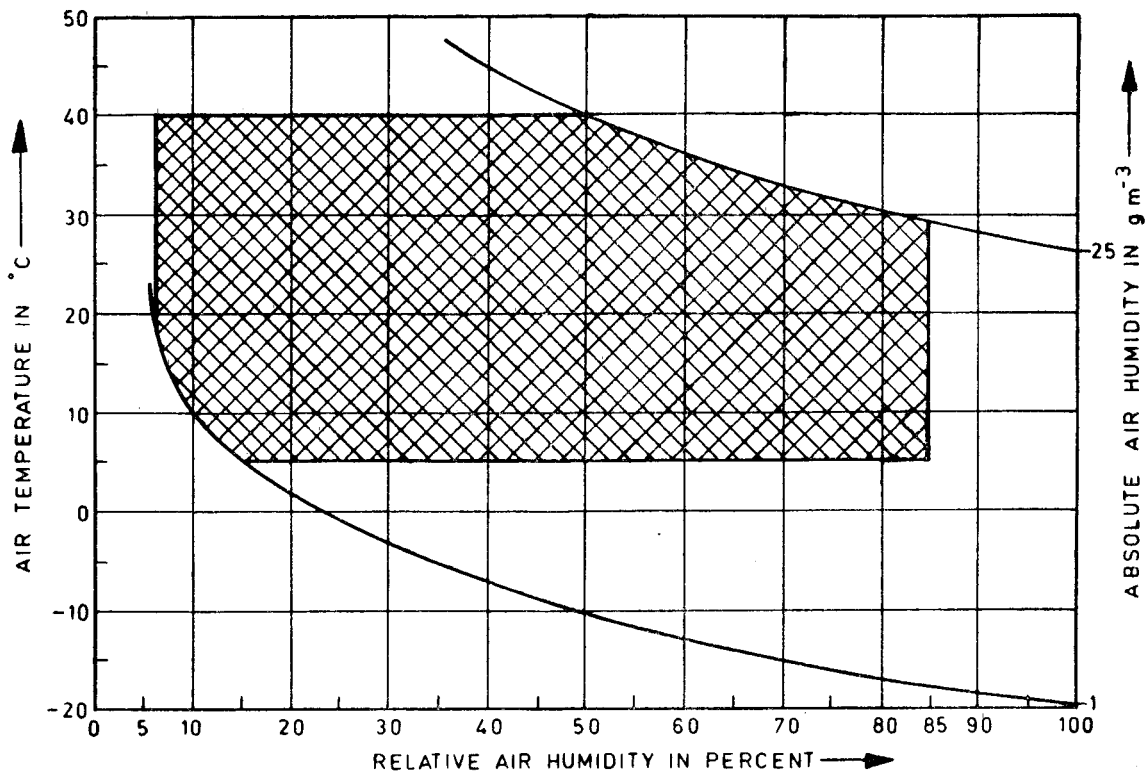


FIG. 1 CLIMATOGRAM (SHOWS ONLY EXTREME CONDITIONS OF COUPLED AIRTEMPERATURE AND HUMIDITY VALUES)

5.3.1.2 For light equipment mounted on supporting structures (for example racks), the amplitudes which may occur are two to five times as high as for floor mounted equipment. This takes into account possible resonances of the supporting structure.

The time of occurrence of these maximum vibrations is expected to be 0.1 percent of the total operating time.

5.3.2 Shock — Shocks through the mounting structure are assumed insignificant. Shocks due to handling are covered by the normal maintenance handling to be carried out during the testing.

5.4 Other Conditions — Conditions of heat radiation, mould and fungus and of dust may apply. However, their effect on equipment reliability is considered to be negligible.

5.4.1 Atmospheric Pollution — The equipment is deemed to operate in rural and urban locations with industrial activities and road traffic. It is expected that the effects of chemically active substances emitted in these areas will not affect equipment reliability.

5.4.1.1 For the effect of higher chemical contaminations, possible in specific environments or applications, appropriate qualification tests are more suitable and should be carried out independently from the reliability testing based on this test cycle.

5.4.2 Electromagnetic Interference — Interference by electromagnetic fields is assumed not to affect equipment reliability.

6. DESCRIPTION OF THE TEST CYCLE

6.1 Operating Conditions

6.1.1 Supply Voltage

6.1.1.1 The supply voltage shall vary as indicated in Fig. 2. The maximum value shall be within 7 to 10 percent and the minimum value shall be within -7 to -10 percent of the nominal. If required in the equipment specification, closer limits shall be maintained.

6.1.1.2 The use of external switches is allowed in order to obtain a significant number of power on/off cycles without the need for attendance during night and weekends or holidays. Small wiring changes of some equipment may be necessary.

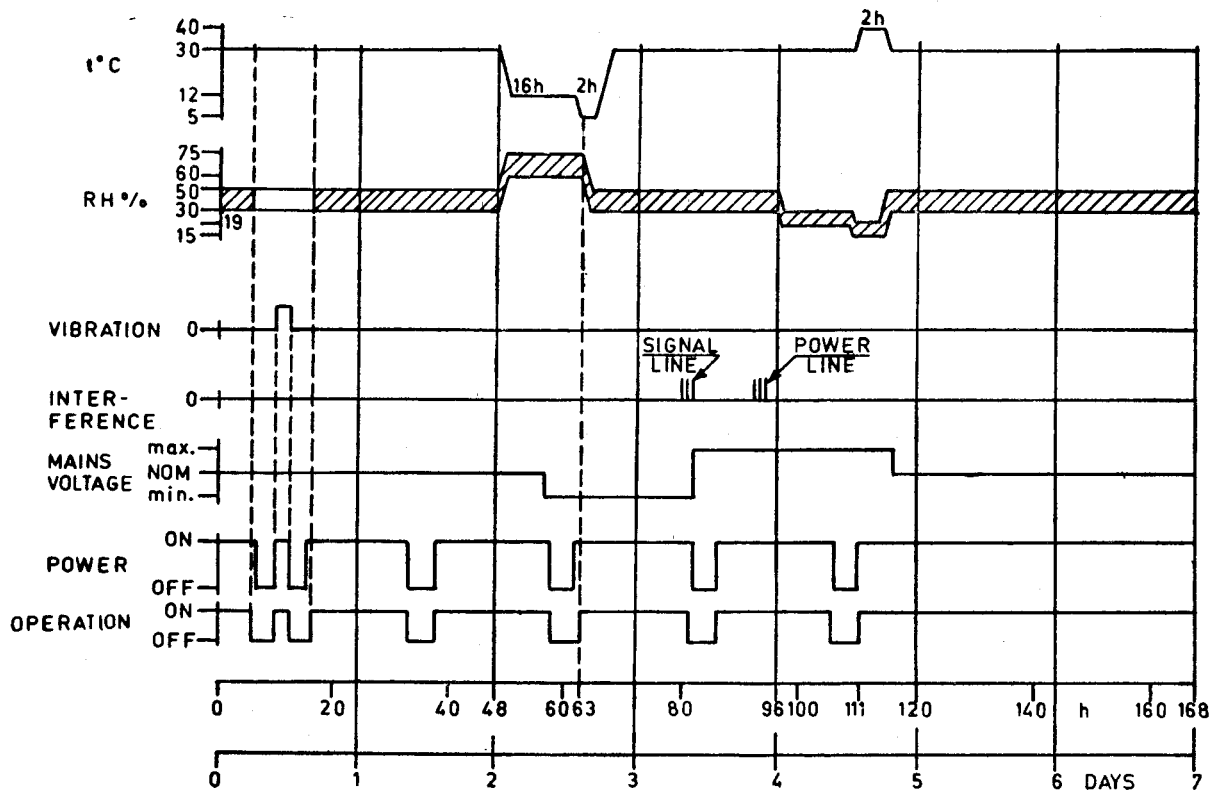


FIG. 2 DIAGRAM OF TEST CYCLE

6.1.2 *Interference by Transient Voltages*

6.1.2.1 The following two tests shall be performed:

- a) Transients on the power line: 5 spikes with peak value 10 times nominal peak voltage of the line, 1 ms duration, at about 1 min intervals, unless otherwise defined in the relevant equipment reliability test specification.
- b) Interference on the signal lines as defined in the relevant equipment reliability test specification.

6.1.2.2 Other types of interference may also be considered, if these have an effect on the equipment reliability.

6.1.3 *Equipment Functional Modes*

6.1.3.1 The power supply shall be switched on and off as shown in the diagram. For equipment which is continuously in operation, the switching off is omitted except for equipment handling purposes (for example, vibration test).

6.1.3.2 Whenever applicable, different modes of operation shall be applied according to a profile defined in the relevant test specification.

6.2 Climatic Conditions

6.2.1 The temperature and humidity during the test shall be varied as prescribed in the diagram of Fig. 2. The test procedure is in accordance with IS : 9000 (Part 3/Sec 5)-1977*, except that the humidity during part of the cycle shall be controlled.

NOTE — Care should be taken to avoid exposure to solar radiation, heat radiation, conditions of condensation, fungus, air pollution and dust.

6.3 Mechanical Stress

6.3.1 *Vibration*

6.3.1.1 One out of the following two tests shall be performed as indicated in Fig. 2 with the equipment in operation.

*Basic environmental testing procedures for electronic and electrical items: Part 3 Dry heat test, Section 5 Dry heat test for heat dissipating items with gradual change of temperature.

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Sinusoidal vibration according to IS : 9000 (Part 8)-1981*, sweep 5 to 55 Hz, in the most vulnerable direction with the test items in the normal attitude of operation:

<i>Equipment Type</i>	<i>Displacement Amplitude Below the Crossover Frequency</i>	<i>Acceleration Amplitude Above the Crossover Frequency</i>
	mm	m/s ²
a) Lower crossover frequency; floor mounted	0.35	1
b) Lower crossover frequency; structure mounted	0.75	2

The vibration may be performed under standard atmospheric conditions for testing, as defined in IS : 9000 (Part 1)-1977*.

6.3.1.2 Attention shall be paid to the fact, that the mass and size of the test item and the available vibrator may limit the possibility of performing the test. If this situation applies, any necessary modifications have to be agreed mutually and specified in the detailed reliability test specification, accordingly.

NOTE — If the equipment under test is moved (for example, preparation of the vibration test), it should be handled with extreme care in order to avoid unintentional increase of the mechanical stress corresponding to normally careful handling.

7. RELEVANT TEST TIME

7.1 The general definition of relevant test time is given in IS : 8161 (Part 1)-1976†.

7.2 The relevant test time includes scheduled on- and off-periods according to the diagram in Fig. 2. Down time for repair or preventive maintenance or interruptions for re-setting up and transfer to different test facilities is not counted as relevant test time.

*Basic environmental testing procedures for electronic and electrical items:
Part 8 Vibration (sinusoidal) test.
Part 1 General.

†Guide for equipment reliability testing: Part 1 Principles and procedures.

INDIAN STANDARDS
ON
EQUIPMENT RELIABILITY TESTING

IS :

8161 Guide for equipment reliability testing:

- (Part 1)-1976 Principles and procedures**
- (Part 2)-1986 Design for test cycles**
- (Part 3) Preferred test conditions for equipment reliability testing:**
 - Sec 1-1986 Indoor portable equipment (low degree of simulation)**
 - Sec 2-1986 Equipment for stationary use in weather protected locations (high degree of simulation)**
- (Part 4)-1985 Procedure for determining point estimates and confidence limits from equipment reliability determination tests**
- (Part 5)-1981 Compliance test plans for success ratio**
- (Part 6) Tests for validity of a constant failure rate assumption**
 - Sec 1-1983 Chi-square test**
 - Sec 2-1987 Kolmogorov Simirnov test**
 - Sec 3 Bartlett's test**
- (Part 7)-1977 Compliance test plans for failure rate and mean time between failures assuming constant failure rate**
- (Part 8) Tests for the validity of a non-constant failure rate assumption**
- (Part 9) Compliance test plans assuming Weibull distribution of time to failure**
- (Part 10) Compliance test plans assuming normal distribution of times to failure**
- (Part 11)-1983 Flow chart describing preparations for the execution of reliability tests**

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

QUANTITY	UNIT	SYMBOL
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

QUANTITY	UNIT	SYMBOL
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

QUANTITY	UNIT	SYMBOL	DEFINITION
Force	newton	N	1 N = 1 kg.m/s ²
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m ²
Frequency	hertz	Hz	1 Hz = 1 c/s (s ⁻¹)
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m ²

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